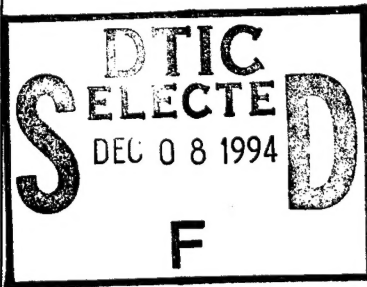


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Surviving the Peace

Lessons Learned From the Aircraft Industry in the 1920s and 1930s



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Abstract

Many of America's defense industries are struggling to survive in today's peacetime environment. As they prepare for the future, US business and government leaders can learn from defense industries that survived the last extended peace. This paper examines the American aircraft industry during the peace from 1920 to 1939. During that time, the industry retained core capability for future defense needs while establishing alternative markets for its products. They succeeded because they placed a strong emphasis on broad based R&D and conducted a concerted effort to establish alternative markets. Industry and national leaders used those alternative markets to strengthen the industry and the national economy. The federal government supported industry efforts by funding research and development, establishing a national aviation infrastructure, and opening foreign markets. The Congress also funded military aircraft production that helped the industry weather market downturns. Although commercial markets existed, aircraft manufacturers failed to achieve independence from government contracts. This failure was due to government procurement practices, poor business management by aviation pioneers, the high cost of technology development, and the small size of commercial markets. Today's defense industries should study the lessons of the aircraft manufacturers as they determine business strategy for the 1990s. The federal government can also apply these lessons as it makes decisions regarding research investments, military-commercial integration, acquisition reform, and export policies. We can never repeat history, but we can learn from it. By studying the lessons of the last extended peace, perhaps we can avoid the mistakes and duplicate the successes.

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Abstract

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INTRODUCTION - REPEATING HISTORY

Only a failure of the United States government to place orders with our successful airplane designers and builders will cause our aircraft industrial strength to slip back into the position it occupied three years ago. A vital point is being overlooked by the American people. It is immediately evident that the industrial strength of the United States must be at the war strength all the time. ...The government must stimulate and aid in the application of aircraft industrially, and also aid in foreign trade, furnishing sufficient outlet for industrial aviation and guaranteeing a continuity of production at the required rate. (Glen Martin, 1920)

With these words, aircraft manufacturer Glenn Martin pleaded with the federal government to help the aircraft industry adjust to peace after World War I (3:119). He recommended the federal government help the industry. He wanted the government to do more than purchase aircraft. He believed the government should help establish commercial markets and foreign trade. In 1993, the Defense Conversion Commission called for similar federal action. The Commission recommended the government work with the defense industry to preserve capability while integrating defense firms into the commercial market place (6:iv). As the federal government prepares to help today's defense industry, it can learn from examining how the country responded to Glen Martin's plea.

In this paper, I'll examine the American aircraft industry during the peace from 1920 to 1939. After briefly reviewing the industry's history, I'll identify the actions that enabled the industry to survive the peace and establish other markets for its products. In addition, I'll identify the reasons it did not achieve independence from US government contracts. Finally, I'll summarize lessons learned for potential application in the defense industrial base of the 1990s.

LIVING FROM HAND-TO-MOUTH -- HISTORY OF AVIATION 1920-1939

The aircraft manufacturing industry of the interwar years merits study by today's defense industries. Like several of today's defense-oriented industries, aircraft manufacturing was originally dependent on defense contracts. However, between the world wars, the industry grew

and also established commercial markets. Therefore, its history may provide some lessons learned for transitioning to a peacetime economy.

The industry entered the 1920s in a strong position after a large buildup for World War I. In 1918, there were twenty-four manufacturing firms. Over three hundred factories produced airplanes at a rate of 21,000 per year (15:45; 12:2). Aircraft manufacturers had a booming business.

However, at the end of the war, the industry declined precipitously. Within three days of the armistice, the government canceled over \$100,000,000 in contracts (5:18). Between 1919 and 1924, the Army Air Service distributed only \$19,000,000 in aircraft contracts (13: 44). This was the result of limited Congressional appropriations reflecting Americans disinterest in buying military weapons (12:3). Later, President Coolidge would say: "Why don't they buy one airplane and let the aviators take turns flying?" (7:2) In addition to few new contracts, manufacturers faced competition from the government sale of war surplus (5:18; 14:365). The industry went from boom to bust in a matter of months.

No market for new military aircraft forced the industry to downsize. Total investment in manufacturing fell from \$23,000,000 in 1918 to \$5,000,000 in 1919 (15:45; 3:116). Production dropped to twenty-five aircraft. Ninety percent of production facilities closed in 1919 (3:116). Many manufacturers left the business. General Motors returned to concentrating on automobiles (20:43). Malcolm Loughead, an aviation pioneer, started a hydraulic brake business (3:126). Aircraft designer, Jack Northrop, sold real estate (3:127). The loss of military contracts devastated manufacturers because they had no other customers.

After World War I, there was no commercial market for aircraft. Historian Wayne Biddle describes the state of commercial aviation after the war as nonexistent (3:136). The war presented the aircraft as a military weapon. Many feared flying (20:56). Obsolete military aircraft frequently crashed because of poor design (15:49). In addition, the nation had few airports, repair facilities, navigational aids, and safety standards for aviation (14:365). Thus, there was no commercial aviation market for manufacturers.

Those firms that survived did so because of government contracts. Glen Martin Company remained solvent by relying on a few remaining wartime contracts. Martin spun off derivative aircraft to the post office for airmail (3:123). Curtiss Aeroplane and Motor Company and Pratt & Whitney, an engine manufacturer, survived on Navy orders (16:7). These and a few smaller companies were all that were left by the mid-twenties.

Even these companies did not have an easy existence. As shown in Table 1, there was no systematic pattern to military purchases. In addition, the military conducted all purchases through competitive bidding. A company could invest in a new design and build a prototype. The Army would then choose one company's prototype. However, the production contract might go to a different manufacturer. The total aircraft produced might only be a small number. This made it impossible for firms to get back their investment. As a result, the industry was living "hand-to-mouth" (12:18).

Table 1
Aircraft Production, 1920-1925 (12:18)

Year	Total Aircraft	Military	Civilian
1920	328	256	72
1921	437	389	48
1922	263	226	37
1923	747	687	56
1924	377	317	60
1925	784	447	342

The fate of the industry began to turn in 1924. In the early 1920s, Gen Billy Mitchell proved the aircraft's value as a weapon. This led the government to examine its approach to aviation. The result was two separate national reviews of aviation policy begun in 1924 (14:365). A committee led by Congressman Lampert found that a lack of definite government policy for commercial aviation and military orders was slowly stifling the industry (15:61). The second review board, the Morrow Board, provided an exhaustive report. The Board's recommendations resulted in legislation which set the stage for a national aviation policy (14:365). Aviation

pioneer, Donald Douglas, considered the board a turning point, "After the Morrow Board, aviation started to become respectable." (3:146).

The Board's report led to four major aviation laws. The Kelly Air Mail Act of 1925 transferred air mail operations from the US Post Office to private enterprise (14:365). The Air Commerce Act of 1926 represented the first attempt at a national aviation policy (14:365). It regulated interstate flying and brought commercial aviation under the control of the Department of Commerce (4:37). The Naval Aircraft Act and the Air Corps Act followed. They set up five year expansion programs for the Navy and the Army. This provided an opportunity for production contracts (3:146). Thus, the legislation opened up new opportunities for the manufacturer.

In addition to the impetus from a national aviation policy, commercial aviation began to gather momentum. Interest in aviation grew as American aircraft began to set records for speed and distance (15:54). In 1927, Charles Lindbergh put aviation in the limelight when he flew from New York to Paris nonstop (5:21). Per aircraft historian, John B. Rae, "More than any other single factor, his flight sold the American people on commercial aviation." (12:35)

Lindbergh's success sparked investment in the aircraft industry. Investment rose from \$15,000,000 in 1926 to \$125,000,000 in 1928 (12:34). Interest in aviation industry stocks soared as did almost all stocks in the late 1920s. In May 1927, Wright Aviation stock sold for \$25 per share (5:21). By 1928, it had reached \$245 per share (15:76). By 1929, aviation stocks reached \$1,000,000,000 on the New York Stock exchange (5:130; 3:157). Now the aircraft industry had capital to invest.

Public interest and investment capital helped the growth in commercial aviation. Airmail grew from a total of 810,555 pounds in 1926 to 7,772,014 pounds in 1929 (4:42). Airline passengers climbed from 5,782 in 1926 to 173,405 in 1929 (4:48). Air transport lines doubled in mileage between 1927 and 1928 (15:66). Americans used aircraft for treating crops, conducting photographic surveys and carrying business cargo (4:21). Many major cities established airports (15:66). This growth sparked sales of civilian aircraft. In 1928, commercial sales of aircraft

exceeded military purchases for the first time (15:66). The industry now had a commercial market.

The potential for large profits in the commercial market attracted businessmen. As a result, large holding companies formed. Executives unfamiliar with aircraft manufacturing headed the firms (8:3). Four holding companies dominated the industry: (1) General Motors - North American Aviation Group, (2) Curtiss-Wright Corporation, (3) United Aircraft and Transport Corporation (United), and (4) Aviation Corporation of Delaware (5:21). As shown in Table 2, two of these corporations accounted for eighty-one percent of aviation sales from 1927 to 1933. The third largest sales were those of Donald Douglas Corporation who received partial funding from the North American Aviation Group (3:180). Big business had come to aircraft manufacturing.

Table Two
Aircraft and Engine Sales, 1927 - 1933 (12:43)

Company	Total Sales	% Total Sales
United	78,240,651	42.3
Curtiss-Wright	71,569,107	38.7
Douglas	15,850,413	8.6
Glenn Martin	9,895,605	5.4
Consolidated	5,425,863	2.9
Great Lakes	3,357,712	1.8
Grumman	605,687	0.3

Not only did these corporations dominate manufacturing, they also owned most of the air transport corporations. They handled ninety percent of the airmail routes (15:90). By 1929, most manufacturers were part of firms that had diversified into commercial operations.

Success came to a halt with the Depression in October 1929. Sales dropped from \$71,153,000 in 1929 to \$26,460,000 in 1933 (15:73). The number of manufacturing firms dropped from 215 to 12 (18:56). Commercial sales dropped from a high of 5,516 aircraft in 1929 to 803 aircraft in 1932 (15:73). As it had done a decade earlier, the industry had to downsize dramatically. Military sales became the only way to survive. In 1936, two-thirds of the industry's

business was military purchases (15:99). The Depression put an end to the manufacturers boom years.

The industry's return to dependence on military sales attracted Congressional attention. Because only a few firms actually received government contracts, Congress grew concerned over possible excessive profit taking. In 1934, the Crane Committee claimed holding companies had prevented the free development of aviation (15:73). The 1934 Air Mail Act forced the holding companies to separate manufacturing from air transport (5:22). In addition, Congress limited profits on Navy contracts to ten percent (3:232). Thus, in the 1930s, manufacturers saw tighter restrictions.

After the initial downturn due to the Depression, the remainder of the 1930s saw growth in the industry. The airplane became the focal point for the World War II defense buildup. Most of the new business came from either US or foreign military sales (20:188). Commercial aviation grew as well. However, that did not provide a market for new aircraft. Most commercial firms maintained their old aircraft (10:37). By the eve of World War II, the US aircraft industry was again dependent on government contracts for survival.

Thus, the history of the aircraft manufacturing industry in the 1920s and 1930s is one of both successes and failures. The industry survived the peace and provided core manufacturing capability to start World War II mobilization. In the process, it successfully established two alternative markets for its products: commercial aviation in the US and foreign sales. On the other hand, the industry never eliminated dependence on government contracts. In sum, the industry survived to be responsive to national defense needs but didn't achieve financial independence from the government.

SURVIVING AND DIVERSIFYING: LESSONS LEARNED FROM SUCCESS

This history reveals that the aircraft manufacturers did accomplish two of the Defense Conversion Commission's goals for the 1990s. Specifically, the country retained a core capability for future defense needs and established alternative markets for a defense industry (6:iv). The

actions of the industry and the federal government that led to this success can provide some valuable lessons for today's government and business planners. These lessons can be summarized as:

- 1) Place strong emphasis on broad-based research and development (R&D),
- 2) Conduct a concerted effort to establish alternative markets,
- 3) Use alternative markets to strengthen the industry and the national economy, and
- 4) Provide a federal safety net to help the industry weather market downturns.

The following section discusses each lesson and identifies specific industry and government actions taken.

Lesson One: Push the Envelope

Perhaps the most critical factor in the industry's survival in the early 1920s was the dedication to R&D. Those firms that survived the early 1920s sacrificed profits for the sake of designing new aircraft (15:59). The manufacturers earned a government commitment to perform all research in the private sector. In exchange, manufacturers agreed to reinvest all profits into R&D (15:54; 5:20). This allowed the industry to increase federal funding support. Most surviving firms adopted this philosophy throughout the early 1920s (15:59). In contrast, aviation pioneers, the Loughheed brothers, failed by following a strategy of selling and producing World War I vintage aircraft (3:127). Thus, the successful survival strategy was to emphasize R&D.

The Douglas Aircraft Corporation is an example of this successful approach. Donald Douglas used a Navy R&D contract for torpedo planes to help start Douglas Aircraft (16:7). Without this R&D contract and the others that followed, Douglas could not have started a new aircraft company when others were failing (3:132). With his first aircraft, Douglas established a reputation for breaking new ground in aviation technology. His Cloudster was the first aircraft capable of lifting a useful load exceeding its own weight (9:9). He followed this success with the development of the World Cruiser. Douglas attributed his success to the reputation his firm earned from these technological feats: "The development of the World Cruiser was probably the

best thing that occurred for us. It made us known. That opened up an opportunity for doing Air Corps business that hadn't existed before." (3:136) This development along with Douglas's torpedo aircraft design for the Navy established him as the premier aircraft designer (9:9).

A firm that took a similar approach was Boeing Aircraft. Historian Eugene Bauer relates how William Boeing managed his firm by adopting the philosophy of "reaching for a piece of untravelled sky." (2:30) In 1921, William Boeing committed his own money to develop a new light-weight maneuverable fighter (2:37). By introducing technology such as welded steel tubing fuselage and tunnel mounted radiators, Boeing established a reputation as a leader in military aircraft production (2:40). According to Bauer, "Boeing's new successes seemed to assure the survival and growth of the company." (2:41) R&D was at the heart of Boeing's successful strategy.

In another example, Lockheed owed its rebirth to technological innovation. Lockheed had fallen into bankruptcy in 1931 (3:167). This bankruptcy was the result of a 1930 management decision not to invest in R&D but to try to survive on operating production lines (3:155,168). Under new ownership in 1932, Lockheed heavily invested in a new all-metal transport, the Electra. The gamble paid off. By the end of 1934, Lockheed had over \$500,000 in sales. The company made its first profit in the first month of 1935 (12:66). In 1935, Lockheed made a profit of \$218,000 on sales of \$2 million (12:66). Again, an aircraft manufacturer succeeded through technological innovation.

Although corporate investment in R&D was critical to its survival, the federal government's management of R&D was more important. The US government was the primary source of R&D funds. How the federal government managed R&D determined what the nation gained from the investment. The government's approach was to diversify R&D by conducting three separate programs: Army, Navy, and National Advisory Committee for Aeronautics (NACA). Each of these programs significantly contributed to aviation development.

The federal government coordinated the three programs to avoid duplication and to provide a broad coverage of aviation needs. The Army program focused on aircraft engine

development. In addition, Army research into metallorganic compounds provided breakthroughs in new fuels (12:26). This research had a significant impact on the reliability and lifetime of aircraft engines (15:108; 12:26). The Army needed more powerful and reliable engines for large, long range bombers (4:108). Long range bombers were the heart of the Army Air Corps' strategic bombing doctrine (4:11). In contrast, Navy investment focused on airframe design and reducing weight, attributes needed for carrier aircraft (12:24). The two different focuses enabled the US to use the Army's strategic bombardment doctrine as well as the Navy's carrier air doctrine. In contrast, British research during the interwar years neglected carrier aviation and therefore limited their doctrine for World War II (12:25). Dr. Robert Schlaifer, a scholar in aviation technology, attributes this division as the heart of the success of the US research:

The existence of two independent agencies meant that the mistakes of one were corrected in a surprisingly large number of instances by the actions of the other. ... there can be no doubt that the sponsorship and direction of development by two separate agencies brought results worth much more than the cost. (12:26)

Complementing the military research was non-defense R&D. This research was under the direction of the NACA. Formed in 1915, the NACA engaged in research and other programs to promote aviation (4:100). The NACA avoided duplicating research carried out by the Army and the Navy (12:24). It focused on aerodynamic research. Its research produced basic data for pioneering work in wing improvements, retractable landing gear, and alignment of engines (12:25). This research improved the efficiency of air transport planes saving the industry \$5 million in 1932 (4:101). Historians attribute the NACA development of the cowling as the most successful aeronautical innovation of the 1920s (4:101). Thus, NACA research focused on aspects of aviation not motivated by military needs. Consequently, its results provided payoff for commercial as well as defense aircraft design.

Perhaps the most valuable aspect of the NACA program was that the NACA provided results to everyone. NACA sponsored industry conferences allowed exchange of results and ideas (4:103). It freely distributed reports (4:103). In 1929 alone, the NACA issued over 100,000 technical notes, memos, and circulars (4:101). The US Civil Aeronautics Board attributes the

pioneering research and the dissemination of information by the NACA as "among the most important factors in aviation progress" (3:103). The NACA played a key role in sharing research results.

The combined influence of these three R&D programs was greater than the sum of their individual results. Aviation historian, Richard Smith, reports that the piecemeal addition of developments had only limited effects (17:35). The real benefits of technological developments came from planes designed with all developments considered (17:35). Thus, the greatest contribution of the government's R&D program was the combined results of all three programs. This was made possible by the NACA's effort to share information.

The greatest contribution of R&D was not the value it had for military aviation. It was the impact R&D had on establishing alternative markets. In the mid 1920s, new developments in military aircraft enabled Army and Navy planes to improve in speed and endurance (4:11). As a result, they won races and set new world records (15:54; 3:125). These successes helped to win public interest in aviation (4:126).

More importantly, technological advances enabled commercial aviation to become a reality. In particular, the technological developments of the 1920s were key to the growth of the air transport industry. First attempts at commercial air transport were unsuccessful because they used old military surplus aircraft. These planes were not well suited for long flights and carrying cargo (4:32). Technology improvements were incremental. The first key development for air transport was Donald Douglas' Cloudster in 1920 (16:7). Later, air mail expansion owed its success to Boeing's development of the Model 40 (4:39). This airplane used larger Pratt & Whitney engines developed for military planes (4:39). Historian Roger Bilstein reported that by 1925, the new generation of engines and transport aircraft created opportunities for air express, passenger travel, and air mail (4:55). Aviation expert, E. P. Warner, believes "In determining the economic success of the airlines --- the role of the airplane designer has been more than influential. It has been absolutely controlling." (4:103) Thus, technological developments provided the machinery to make commercial aviation possible.

R&D efforts also opened markets in Europe. The superior speed of Lockheed's Orion attracted business in Europe. It proved its worth by outpacing Europe's fighter aircraft (17:38). Switzerland purchased the Orion for Swissair air mail routes (17:38). In addition, Douglas' DC-2 matched the performance of the "finest long distance racing planes" while carrying 900 pounds of mail (17:39). Thus, superior technology opened European markets for Americans.

Lesson Two: New Markets through Team Effort

Technological developments alone were enough to get commercial aviation going. Of equal importance was the concerted effort of industry and government to establish commercial aviation. The aircraft manufacturers made a critical decision when they recognized they must find other markets besides the military departments. In 1922, industry leader Samuel Bradley told Congress: "If we are to continue looking upon aircraft as military weapons, we should abandon all attempts to commercialize flying. We shall never have an industry if we remain solely munitions makers." (15:55) With a similar theme, Donald Douglas argued against preserving the industry as a government asset:

Many people argue that the government cannot afford to allow this great and new industry to languish because of lack of business, but must foster and further it by subsidy or continued military orders. That such a course would be welcome at this critical period is undeniable but total dependence on this problematic possibility would be fatal. (3:124)

Recognition of the need for a commercial market was only half the battle. The more difficult task was to sell commercial aviation to Americans.

The industry gave the job of promoting commercial aviation to its associations. By forming associations, the industry was in a better position to promote commercial aviation. The first trade association was the Manufacturers Aircraft Association. Established prior to World War I, it administered cross-licensing agreements on aviation patents (15:29). Throughout the 1920s and 1930s, the MAA and its spin off, the Aeronautical Chamber of Commerce (ACC), worked successfully to promote commercial aviation (15:57). The MAA built an information department which supplied data to newspapers and magazines. It supplied fact sheets to civic and

trade bodies, Federal and state authorities, and other industries (15:49). As a result, many more people knew of the capabilities of commercial aviation (15:49). Thus, the manufacturers used the MAA to promote their products.

Later, the ACC became the primary promotional agency for commercial aviation. It published the *Aircraft Yearbook*. The yearbook became a valuable reference throughout industry and highlighted the commercial aspects of aviation (5:129; 20:64; 4:142). The ACC organized air shows and flying meets (20:65). It initiated public landing field campaigns and interested municipalities in building airports (15:57). It got the support of larger businesses to initiate new air mail routes, such as one from New York to San Francisco (15:57). During the expansion years after the Air Commerce Act of 1926, the ACC provided a stabilizing influence by providing education and information to investors and newcomers to aviation (15:65). Through these actions, the ACC increased public awareness of aviation.

In addition, the MAA and ACC served as the industry's spokesmen with the government. The MAA negotiated the agreement to conduct research in the private sector (15:54). The ACC worked closely with the Department of Commerce in getting air mail and air commerce laws through Congress (20:65). It convinced the Interstate Commerce Commission to reduce railroad charges on aircraft parts shipments (20:65). During the 1930s, it worked with the National Recovery Agency to gain funding and set standard practices for the industry (20:106). Through these actions, the associations brought the concerns of the industry to the federal government.

The industry's associations could not have established commercial markets on their own. The federal government also made significant contributions. One contribution was to assume the risks of implementing a new technology. This took two forms: (1) government start-up of air mail and (2) advocacy of air transport through air races. The United States Postal Service started airmail service in May 1918. Airmail flights used war surplus planes and Army veterans as pilots (4:130). By 1925, the postal service had established a permanent clientele in the nation's business and banking industries (4:36). Historian Roger Bilstein believes the government operation of air mail:

- 1) Encouraged the formation of viable air transportation corporations,
- 2) Accelerated introduction of original aircraft design based on new commercial requirements for carrying mail, and
- 3) Encouraged and accelerated technology developments. (4:110)

In addition to airmail service, the government also contributed to the formation of the air transport business. Around the world flights in 1924 used US Navy and Royal Air Force assets. These exploits demonstrated the possibility of international transport (4:2). In addition, Army pilots were the first crop dusters and flew the first fire patrols for the Forest Service (4:75). Bilstein attributes the Army and Navy's demonstration of the flexibility of aircraft as key to the integration of the new technology into national life (4:28). These efforts not only gained the American public's interest in aviation, but also demonstrated the feasibility of commercial aviation. Thus, the government set the stage for private investment. However, perhaps the government's greatest contribution to commercial aviation, came in other areas.

Despite the growing interest in aviation, obstacles to its growth still existed in 1924. The ACC identified the primary issues that impeded the development of air transport companies:

- (1) Inspection and certification of airplanes, engines, and pilots,
- (2) Establishment of air ports,
- (3) Charted and lighted airways,
- (4) Air law to safeguard passengers,
- (5) Insurance, and
- (6) A nation-wide meteorological service (15:59).

The ACC called for a comprehensive national air policy to correct these deficiencies (15:59). Only the federal government could correct these problems.

The government responded to the needs. The Army Air Service laid out and charted several air routes (15:59). The Air Service's Model Airways System linked air fields in the Midwest and provided ground staff (4:16). The Postal Service completed a transcontinental system between New York and San Francisco (15:59). It developed a system using beacons from

coast to coast. This allowed twenty-four hour operations and enabled air mail to beat train transportation by three days (4:35). The Postal Service provided thousands of miles of air routes for comprehensive long-range, all-weather day and night operations (4:35). Bilstein credits these developments with placing America in the lead in air transport (4:35). Thus, the federal government had built the nation's aviation infrastructure.

In addition to these efforts, a significant step toward building infrastructure was the Air Commerce Act of 1926. This act created the Aeronautics Branch of the Department of Commerce (4:37). The branch had a wide range of responsibilities:

- a) Constructing more lighted airways and navigational aids,
- b) Licensing planes and pilots, and
- c) Framing a set of regulations that covered everything from flight training to proficiency requirements (4:37).

The Branch made strides in these areas and others. A program of medical examiners was established. The branch initiated procedures for certification of air frames and engines. Aviation branch programs focused on safety, public relations and airport development (4:141). These initiatives provided the basic infrastructure commercial aviation needed.

ACC chairman, Samuel Bradley lauded the efforts of the government which began in 1926 as the turning point for commercial aviation:

During that year (1926) aeronautics in the United States became permanently established upon a sound program of constructive legislation...We had the basic law giving legal authority for carrying on their work and for the assistance of the government, through the Dept. of Commerce, in maintaining airways and aids to navigation. (15:64)

Infrastructure played a major part in the commercial aviation's growth between 1926 and 1929. In 1927, air transport lines doubled in mileage. Privately owned aircraft increased from the hundreds to the thousands (15:65). Historian John Rae attributes this growth to the federal government's improvement and extension of airfields and navigation aids (12:23). Thus the government provided something that only it could do: infrastructure for commercial aviation.

Besides the contributions to the domestic commercial market, the government played a key role in establishing foreign markets. Initially, the manufacturers resisted foreign sales, but the government promoted it by creating the Bureau of Foreign and Domestic Commerce (BFDC) (20:108). It was a branch of the Commerce and State Departments (20:108). The BFDC used military and commercial attaches in American embassies to promote foreign sales (20:111). It appointed aeronautics trade commissioners for Latin America and China and funded industry participation at the Paris Air Show (20:111). One aircraft manufacturer called the BFDC "the greatest single influence at the service of the American manufacturer and exporter in developing and maintaining a flow of free foreign trade." (20:110) Thus, through the BFDC, the federal government opened new foreign markets for manufacturers.

The government went further than just promoting sales. It integrated aviation into US foreign policy. Aircraft sales became an integral part of the Good Neighbor Policy in Latin America and the New Deal policy abroad (20:189). The Export-Import Bank provided loans for Latin American countries (20:189). In 1939, the Hemispheric Defense Plan provided one hundred percent financing for aircraft sales to Latin America (20:189). The policy went beyond military to commercial aviation. Nelson Rockefeller stated the American goal: "The complete Americanization of aviation in the entire Western Hemisphere with particular respect to Latin America." (20:190) The US took the lead in exporting aircraft in 1938 when US aircraft accounted for forty-five percent of exports from all the principal producing countries (15:105). Thus, by integrating aircraft sales into foreign policy, the government helped aircraft manufacturers enter the foreign market.

Lesson Three: Take Advantage of Alternative Markets

Diversifying into commercial and foreign sales didn't end dependence on government contracts. However, it did help the industry survive. These markets helped to fill the gaps left by government procurement policies. In addition, they brought aircraft manufacturers new capital and investment. These new markets also induced R&D efforts that later helped aircraft

manufacturers compete for military contracts. In truth, many in the industry would not have survived without diversification.

A primary example of the value of diversification is the Boeing Company. At the end of World War I, loss of military contracts forced William Boeing to build furniture to keep his plant open (2:32). Boeing's solution was to diversify both horizontally and vertically. First, Boeing entered into aviation operations through air mail routes (4:38). His firm flew the first airmail from Seattle to Vancouver Island in 1919 (4:38). Airmail helped Boeing keep alive his R&D efforts and gave him a useful background in airline operations (4:38). By combining the knowledge gained from building military planes with air mail experience, Boeing became a dominate figure in the bidding for new airline routes in 1926 (4:39). This successful vertical diversification brought horizontal diversification by bringing commercial design work to the corporation (2:51). Thus, Boeing's venture into air mail provided income for survival and gave him a new market for his aircraft manufacturing segment.

Grumman also made diversification a cornerstone of its business. Grumman's first business was aircraft repair and building aluminum truck bodies (8:7). The firm's first military contract was for parts for the Navy (8:8). Grumman did not get its first contract for a full aircraft for almost two years after company start-up (8:10). Later, the firm transitioned into sale of civilian aircraft. In 1939, commercial sales boosted profit margin to 19.9%, its highest ever (8:10). As aviation historian, Gene Francillon points out: "This began a tradition of diversification programs which helped Grumman survive." (8:7).

Although he didn't need it to survive, Donald Douglas, also found diversification a successful strategy. For Douglas, commercial sales proved more profitable than military sales. Commercial sales had a 17.7% profit margin compared to less than 10% for military contracts (9:18). Per Donald Douglas, "When you design an airplane for one purpose, it proves successful, then you try to find the things you can do with it." (3:134). Douglas shifted designs between the commercial and military market frequently. When his Gamma airplane stalled as a commercial

aircraft, he converted it to an attack bomber and sold it to China (3:193). Thus commercial aviation brought Douglas higher profits and alternatives to defense contracts.

Boeing, Grumman, and Douglas were not the only manufacturers to diversify into the commercial market. By the end of the 1920s, most of the major aircraft manufacturers were in some way associated with air transportation (14:5). Vertical diversification enabled the corporations to secure financial strength for competition and expansion. It also assured markets for their manufacturing segments (14:367). As shown in Table 3, commercial aircraft production out paced military production. Airmail expansion strengthened the growth (14:368). As shown in Table 4, the major aircraft firms got an appreciable amount of their sales from the commercial market. Thus, by diversifying into commercial sales, manufacturers increased their business base.

Table 3
Aircraft Production 1932-1939 (12:81)

Year	Total	Military	Civil
1932	1,396	593	803
1933	1,324	466	858
1934	1,615	437	1,178
1935	1,710	459	1,251
1936	3,010	1,141	1,869
1937	3,773	949	2,824
1938	3,623	1,800	1,823
1939	5,836	2,195	3,661

Table 4
Aircraft and Engine Sales, 1927-1933 (10:367)

Company	Government Sales	Commercial Sales	Total Sales
United *	\$50,184,443	\$28,056,208	\$78,240,651
Curtiss Wright	\$44,755,590	\$26,813,517	\$71,569,107
Douglas	\$14,437,623	\$ 1,412,790	\$15,850,413
Glenn Martin	\$ 9,895,605	none	\$ 9,895,605
Consolidated	\$ 4,307,632	\$ 1,118,231	\$ 5,425,863
Great Lakes	\$ 2,451,993	\$ 905,719	\$ 3,357,712
Grumman	\$ 452,195	\$ 153,492	\$ 605,687

*United included Boeing, Chance-Vought, and Pratt and Whitney.

Besides providing an expanded sales base, commercial aviation attracted private investment. Investment went from \$18 million in 1926 to \$125 million in 1929 (12:34). Bankers

interested in air mail prompted investment in air operators (4:33). The Commercial National Bank & Trust Co. reported that from 1927 to 1929, \$500 million was available for aeronautic development (4:130). This capital investment helped the industry endure the stock market crash and the early 1930s (12:51). Diversified firms survived after the crash. Most independent manufacturers went bankrupt (14:367; 18:5). Thus the commercial market, although volatile, helped the industry by providing investment dollars.

The investment financed new aircraft design inspired by the needs of commercial air transport. One example was Donald Douglas's development of the DC series aircraft. Trans World Airways contracted the development of the DC-1 and DC-2. American Airlines sponsored the development of the DC-3. American, Eastern, and United sponsored the DC-4 (9:17). Lockheed also benefited from commercial design work. Lockheed's Vega aircraft, a commercial air transport, helped Lockheed flourish. Later, its Electra enabled the company to climb out of bankruptcy (2:60; 3:155). Hence, diversification led to new aircraft designs.

Thus, the development of commercial aviation benefited the aircraft manufacturing industry. However, the most significant impact of the commercialization of aviation was increased national productivity.

The introduction of commercial aviation was felt throughout American business. Bankers were the first to benefit. To bankers, air mail meant money. Even in the early 1920s, limited airmail routes provided monetary gains for banks (4:35). The banks found they could reduce the idle time on funds (4:35). By the early 1920s, banks used airmail to reduce collection time on checks from five days to two. One banker claimed airmail provided savings of "enormous sums in actual interest and the release of untold millions in float." (4:36) Oil shippers used airmail to forward bills of lading, saving thousands of dollars annually. Advertising agencies sent copy by airmail for less cost than by telegraph (4:40). As expressed by one businessman in 1927, "Use of the airmail is now such an integral part of the business machinery that if anything should arise to injure or destroy it, the hurt would be felt immediately by the commerce of the nation." (4:42)

Commercial airlines and air cargo also contributed to the nation's economic growth. American business was using the new airlines to increase mobility. A 1929 survey revealed that 80 leading companies allowed employees and executives to put air fares on expense accounts (4:53). Thus American companies used passenger airlines to improve mobility and reduce time spent traveling.

American companies also reaped the benefits of air cargo. They averted production line shutdowns by air shipping parts. A printing plant in twenty-four hour operation lost only four hours because it used air cargo to ship a replacement part (4:54). If it had gone by rail, it would have taken days (4:54). Air shipping enabled retail stores to reduce the stock they had on hand, thus reducing inventory overhead (4:54). By the late 1930s, airlines and air cargo services had become an integral part of American business.

Although commercial aviation benefited the nation, it was too small a market for the aircraft manufacturers. They needed another market. They found it in foreign sales. Foreign sales in the 1930s became a major income source. To adjust to declining commercial aviation purchases during the depression, most manufacturers turned to foreign markets. Unrest in China, Latin America, and later Europe fueled sales (14:368). In 1927, the US exported 63 airplanes worth \$848,568. By 1934, exports rose to 490 planes worth \$8,195,484. The 490 planes were out of a total of 1615 aircraft produced in 1934 (14:368). Foreign sales were not an insignificant part of the manufacturer's market.

All the major manufacturers benefited from foreign sales. Glen Martin survived the depression with international sales of military planes to South America (3:186). He also sold bombers to China, Argentina, Turkey, the Netherlands East Indies, and the Kingdom of Siam with large profits (3:239). He made \$2.5 million on twenty-two planes sold to the Argentine Army. As a result, Martin rebounded financially from bankruptcy (3:239). Similarly, Lockheed helped finance the Electra's development with overseas sales (3:219). Donald Douglas sold designs to the Japanese providing them their primary cargo carrier for World War II (3:251). Douglas' DC-3 aircraft became the standard for planes worldwide (12:78). Between 1936 and 1938, Douglas's

sales and incomes nearly tripled, the highest in its history (3:251). For these firms, the export market became a valuable source of sales.

More important than the sales volume was the high profit margin foreign sales provided. Exports accounted for 80% of profits for the aircraft manufacturers in the 1930s (20:188). The aircraft were older designs and mass production was possible (20:188). Since manufacturers had already recouped development costs from domestic sales, profit margins rose to 20% (20:188). Manufacturers could also minimize their risks by demanding large down payments, 20 to 30%, and progress payments (20:188). The ACC reported that these profits were critical. They used the profits to fund R&D and allowed the industry to invest in mass production techniques (20:188). Foreign sales supported two-thirds of R&D costs (20:188). Gay Vaughan of Curtiss-Wright claimed: "The development of airplanes for the future comes from the export business." (20:188) Thus, foreign markets were a valuable source of profits for reinvestment in R&D.

Lesson Four: Provide a Safety Net

Although the government and industry established alternative markets, the industry still needed government production contracts. The Morrow Board identified the need for predictable government purchases. As a result, the Air Corps Act and the Navy Aviation Act of 1926 provided the industry a stable base (14:366). The Navy program provided for 1614 aircraft from 1927-1931. The Air Corps Act authorized the Army to purchase 1800 airplanes (14:366). The industry liked the prospect of production contracts. These contracts would allow them to buy materials in quantity and save on mass production (12:32). The five year plan approved \$435,980,000 for the years 1927-1934 (15:84). This made the government a reliable source of business (15:84). In 1936, the government initiated new five year plans. These helped to carry the industry to the beginning of World War II expansion. Through these five year plans, the government provided a funding source upon which the industry could plan.

This source helped the major firms survive the depressions years when commercial aviation production dropped. In the early 1930s, although only one-third of the airplanes built

were military, they accounted for two-thirds of the total dollar value (3:17). Even Douglas Aircraft Corporation whose airplanes had become the standard for commercial lines, had seventy-two percent of his sales to the government from 1935 to 1938 (15:100). From 1924 to 1938, Consolidated Aircraft sold eighty-one percent of its aircraft to the government (15:100). In effect, the government provided a safety net for manufacturers.

In sum, through these actions the aircraft manufacturer and the government enabled the industry not only to survive the 1920s and 30s but to set up commercial markets. Aircraft manufacturers survived by dedicating assets to R&D. The government helped by providing a broad based R&D program. Both the industry and the federal government conducted concerted efforts to find new markets for aircraft. The government helped by opening new markets with new technology and providing a national aviation infrastructure. The industry used these new markets to provide new investment and improve profitability. The nation used aviation to improve productivity. To dampen the effects of commercial market downturns, the government provided two five year procurement plans. As the result of these actions, the aircraft industry grew and expanded in the interwar years.

NO INDEPENDENCE FROM GOVERNMENT CONTRACTS: LESSONS FROM FAILURE

Despite these successes, the aircraft industry was still dependent on government contracts. In 1937, military sales of aircraft were sixty-five percent of sales (10:2). Glen Martin's books at the end of 1937 show the Navy accounted for eighty percent of sales. Seventy percent of his unfilled orders in September 1938 were for the government (15:100). Even with the successful development of commercial markets, "the dependence of the aviation industry on the government was the keynote of its history." (15:100) The industry needed government sales.

Government procurement practices contributed to this dependency. The government concentrated the industry by awarding production and air mail contracts together. In attempts to reduce risk, the government limited competition to just a few proven firms. From 1927 to 1933, eighty percent of all production contracts went to two firms. Ninety percent of the military

business went to ten companies when there were 296 aircraft firms on record in 1929 (5:21). As reported by the Standard Statistics Company: "In other words, the other 286 companies manufacturing planes have almost no participation in this stable business." (15:84) Even successful commercial aircraft manufacturer, Lockheed, found it impossible to enter the military aircraft business. Lockheed president, Robert Gross said:

"The building and marketing of military and commercial aircraft are two very distinct and different businesses. The laws governing the procurement of service aircraft are so complicated and the process necessarily so long that no airplane can permanently invade the military market without financial resources that this company has never possessed." (3:253)

Thus, the government concentrated the business to only a few viable firms.

They further constrained the business by placing limitations on profits the firms could earn on government contracts. In 1934, Congress restricted profits to ten percent for work for the Navy. The Army contracts remained unlimited until 1939 when Congress limited all profits to twelve percent over five years (3:236). Industry analyst estimated actual profits were only about six percent considering nonallowable expenses (10:12). This made it hard for the industry to attract capital. As expressed by Glen Martin:

"It has not been a business. Federal spending does not provide an opportunity for profit that will interest investment. We cannot induce capital to come in on the basis of the Air Corps Act of 1926 and the treatment that the aircraft manufacturers received since that time. The money invested in aircraft is invested in the thought or hope that somewhere in the future it will be a great business." (3:232)

Aviation investment advisor, Barclay Harding summarized the "challenges" of government procurement in 1937:

- 1) Firms competed and delivered a complete airplane for testing. A firm could spend several hundred thousand on a new plane and then not get a contract
- 2) Firms were never sure there would be enough volume to make it profitable. Repeat orders offered the largest profits because they didn't have tooling and development expenses (10:6).

Thus, the government procurement policies left the industry concentrated, dependent on government contracts, and unattractive to outside investment. As a result, military aircraft manufacturers lived hand to mouth with their food source, the federal government.

In addition, the government's approach to production contracts forced the industry to build up mass production capability. The government envisioned the aircraft industry to be like the automobile industry. This would provide the manufacturing base for military mobilization needs (20:186). Unfortunately, even military contracts didn't provide the volume to support this capacity (10:6). Therefore, manufacturers had large fixed costs and excess capacity. But government procurement practices were not the only culprit.

The industry also contributed to the failure to gain independence from government contracts. The most glaring fault of the industry was poor business practices. Aviation pioneers founded and ran most of the firms. Non-economic goals motivated these pioneers. Aviation historians criticize Douglas for continuing to try to maintain his company as an "engineering shop" (3:159). As reported by historian Jacob Vander Meullen, "they were motivated by patriotism, a drive to improve aviation, and a desire to be on the edge of technology." (20:45) Millionaires such as William Boeing and Henry Ford absorbed millions in losses to keep the business alive (2:32; 20:46). Love of aviation drove their management decisions, not profit margins. As a result, they struggled to interest business investors who wanted higher profits.

They also allowed government procurement policy to drive business decisions. They undercut each other and took losses on government development and production contracts. For example, in 1934, Douglas spent \$730,000 for prototypes of five new Navy aircraft but recovered only \$259,000 (20:194). He subsequently lost \$275,000 on the production contract (20:194). Industry analysts reported losses ranged from 10 to 100% on design and manufacture of a new aircraft (10:12). In the end, the industry bore the burden for new design. According to Clement Keys of Curtiss Aircraft: "If you want an industry that can create a design, that certainly has to be paid by someone. Well we paid it ... our job in the aviation game seems to be to contribute quite a little bit of money year by year to the Army and the Navy for aviation." (20:62)

They also made unwise equipment investments. They built plants for mass production of aircraft without any business planning for follow-on production after the current contract. By the eve of World War II, fifty percent of the industry capacity was unused (20:188). The cycle of build up followed by massive lay-offs repeated through-out the decade. The industry struggled to become a commercial enterprise. It never made the cultural change to a market-driven, profit-oriented industry.

Another factor that contributed to the failure was the high cost of development work. By the 1930s, the cost of building a prototype went from \$10,000 in the early 1920s to \$600,000 in 1939 (20:88). It reached the point that few firms could afford to build a new model without a government contract (20:183). New technology increased the need for capital. The change from wood to tubular design caused a forty-nine percent increase in engineering costs. Monologue fuselages increased costs by fifty percent (3:167). All-metal aircraft required large capital investment for tooling (20:183). A military plane's average cost rose from \$15,461 in 1928 to \$39,063 in 1937 (3:167). Before long, no one but the federal government could afford a new design.

If a manufacturer developed a new commercial design, the market wasn't large enough to make the development profitable and to recoup tooling costs. By 1937, commercial airlines had become a "business proposition" but, according to Barclay, not a very profitable one (10:18). Air passenger volume increased but transportation rates declined. In addition, the airlines had to make heavy expenditures in ground facilities (10:18). As a result, air transport companies had little money for purchasing aircraft. They purchased only a few aircraft and kept them for a long time (10:18-19). When they did buy planes, the airlines bought bigger, more expensive planes but fewer of them (10:18). General aviation and private sales also increased in the 1920s and 30s but the numbers were still small. In 1936, industry analyst, William Harding, predicted the market would remain small because of the cost and skill needed to fly aircraft (10:22). Thus, although commercial markets existed, they could not take over for the defense market.

In sum, there were several reasons aircraft manufactures failed to eliminate its dependence on government contracts. Government procurement practices restricted competition, drove over capitalization, and limited profits. In turn, manufacturers didn't adopt sound business practices and kept the technology pioneer mentality. In addition, the cost of developing sophisticated technology and the small volume of commercial sales limited commercial markets. Thus, as with success, government and industry shared responsibility for failure.

LESSONS LEARNED FOR THE 1990S

The defense industry of the 1990s faces challenges similar to those faced by the aircraft industry in the 1920s. In particular, the defense procurement budget has declined by at least 40% (6:15). Consequently, the defense industrial base has excess capacity. Both industrial leaders and US defense leaders must adjust to this decline. As they decide how to adjust, these leaders may wish to review the lessons of the American aircraft industry. Table 5 summarizes these lessons addressed in this paper.

In particular, today's companies should consider the aircraft industry's actions as they select a business strategy for the 1990s. The Defense Conversion Commission reported that defense firms are considering three different options:

- 1) Rationalizing: concentrating on their core defense capabilities and shedding unprofitable defense business segments,
- 2) Increasing exports, or
- 3) Diversifying into commercial markets (6:19).

In the 1920s, aircraft manufacturers tried all three strategies. But the most successful firms, Douglas Aircraft, Boeing Company, and Curtiss Wright, adopted a combination of increasing exports and diversification. As I discussed earlier, this approach provided the best opportunities for private investment capital. Also it helped manufacturers weather the fluctuations inherent in defense budgets. In addition, this strategy provided the greatest benefits to the national economy. Thus, the American aircraft industry's history indicates the

diversification strategy is the one most beneficial to the industry and the nation. However, the strategy cannot succeed without federal government help.

One area where the federal government can help is through its R&D policy. The current debate within the federal government on defense R&D focuses on three issues:

- 1) Should DoD preserve defense in-house laboratories at the cost of reducing contract R&D funds,
- 2) Should DoD consolidate defense R&D facilities and funds management instead of three separate service programs, and
- 3) How much funding should DoD dedicate to dual-use technology instead of purely defense R&D (6:36-40)?

Again, the aircraft industry's history provides us some insight on these issues. The federal government in the 1920s helped the aircraft industry to survive by contracting for most of its research. Both the government and industry benefited from a policy that emphasized contracted research. Perhaps, government and industry could again benefit from such a policy in the 1990s.

In addition, a key to the success of federal aviation R&D in the 1920s and 30s was the government's three independent but coordinated R&D programs. In the 1990s, the federal government should consider coordinating the military service R&D efforts instead of consolidating them. Finally, the efforts of the NACA to share technology development between the defense and private sector directly influenced the success of military aircraft in World War II and commercial aviation in the late 1930s. The federal government could position the Advanced Research Projects Agency and the National Institute of Standards and Technology to play a similar role today. Thus, as today's defense planners decide how to structure R&D, they should consider these lessons of the past.

Another key issue for the federal government is integration of the commercial and defense industrial base. DoD wants the benefits of an integrated base while preserving defense unique industries (19:9-13). Again, the aircraft industry's history has several examples of the sharing of technology between commercial and military aviation. These examples demonstrate the benefits

of civilian-military integration. On the other hand, the history shows how federal acquisition policy can obstruct integration. As described earlier, federal practices such as underfunding of prototype development, forcing artificial competition and excess capacity, and refusing to provide design rights isolated defense production from commercial production. Many of these conditions still exist in today's defense acquisition system (7:i-iii). Aircraft manufacturing's history indicates that the federal government must change these practices if it wants civilian-military integration.

DoD must also remember that, despite the best efforts at diversification in the 1920s, the federal government had to provide the aircraft industry two five-year plans as a security net. Similarly in the 1990s, Les Aspin's Bottom Up Review recognized the need to include preservation of the industrial base in planning for long-term defense needs (1:55-70). The federal government may have to accept the burden of supporting certain key defense industries.

Finally, an additional technique for maintaining a viable industrial base, is federal government support for export of defense products. This strategy aided the aircraft industry in the late 1930s. In the 1990s, aircraft manufacturing executive, Gerald Johnston believes foreign markets including joint ventures present opportunities to leverage America's investment dollars (11:287). However, with increasing international competition, the federal government may need to act as an advocate as it did in the 1930s. This includes the recommendation of the Commission to negotiate for lower off sets (6:36). In addition, the government could place a priority for opening markets for dual use technology (6:37). Therefore, as the US develops new foreign policies for the post Cold War environment, the federal government should consider creating foreign markets for defense and dual use technologies.

CONCLUSION

As the United States plans to preserve an industrial base to meet military requirements, it would gain from examining the past. As a defense industry that grew during the peace between World War I and World War II, the aircraft industry presents an opportunity to learn from their successes and failures. The aircraft industry went from a state of near collapse in the early 1920s,

to a growing prosperous industry with a strong commercial market in the late 1920s. In the 1930s it struggled and survived on government contracts and foreign sales. The industry was successful in surviving and providing the core capability for World War II mobilization. It also established alternative markets for its products. However, it didn't achieve independence from government contracts. Thus, the industry achieve diversification but not financial independence.

We can learn several lessons form these successes and failures. The industry succeeded because of a strong emphasis on R&D. This included reinvestment of profits by the industry and a broad based federal R&D program which included nonmilitary expenditures. Development of new markets succeeded because of this emphasis on R&D and group efforts to promote commercial aviation. The government contributed by providing needed infrastructure, taking the high risks of developing new markets, and establishing foreign markets. New markets helped the industry survive by supplementing military contracts and providing new investment capital. More importantly, the national economy benefited from the commercialization of aviation. Airmail and air transport improved national productivity and efficiency. Despite these new markets, the federal government still had to provide a safety net. This took the form of two five-year acquisition plans. Finally, the failure to eliminate dependence on government contracts was due to restrictive federal procurement practices, poor business strategies by the industry, the high cost of technology development, and the small volume of commercial sales. Thus, industry and government shared in success and failure.

Today's industrial base planners can benefit from considering these lessons before developing strategies for the future. Defense companies should consider the benefits the aircraft manufacturers gained from a diversification strategy. The federal government should consider the advantages of a policy that favors contracted R&D directed from a broad based R&D program. In addition, as the government strives to integrate the civil and military industrial bases, it should look within its own practices to remove obstacles to the integration. Finally, the federal government should consider proactive measures to open foreign markets for defense products

both military and dual-use technology. The lessons of the 1920s and 30s provide the basis for these considerations.

In sum, we can never repeat history, but we can learn from it. By studying the lessons of the last extended peace, perhaps we can avoid the mistakes and duplicate the successes.

Table 5
Lessons Learned From the Aircraft Industry in the 1920-30s

Lesson Learned	Defense Industry Actions	Federal Government Actions
Place strong emphasis on broad-based R&D	Make a commitment to R&D. Consider reinvesting profits in R&D	Conduct a broad based R&D program which includes non-defense investments
Conduct a concerted effort to establish alternative markets	Use trade associations to perform public affairs functions and to interact with the government in creating new markets Invest R&D dollars to develop products for new markets	Contract for R&D needs to assist industry survival Assume some of the risks of creating new markets with new unproven technologies Invest the national infrastructure needed for new markets
Use alternative markets to strengthen the industry and the national economy	Use new markets to supplement sales from military contracts and attract investment Take advantage of foreign sales to achieve higher profit margins and economies of scale	Help promote foreign markets by integrating sales into the national foreign policy View new applications of defense technologies as opportunities to improve national productivity and international competitiveness.
Provide a government safety net to help the industry weather market downturns		Provide a baseline procurement program as an industry safety net
Recognize that diversification may not eliminate dependence on government contracts	Minimize dependence by adopting good business practices	Revise procurement policy to eliminate artificial competition, provide for compensation for R&D, and allow reasonable profits OR accept industry dependence on government contracts.

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